



Industrial Waste Air Model Technical Background Document

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Acronyms and Abbreviations

ADI	Acceptable daily intake
ATSDR	Agency for Toxic Substances and Disease Registry
CAA	Clean Air Act
CAG	Carcinogen Assessment Group
CalEPA	California Environmental Protection Agency
CAS	Chemical Abstract Service
CSF	Cancer slope factor
CSTR	Continuously stirred tank reactor
EFH	<i>Exposure Factors Handbook</i>
EPA	(U.S.) Environmental Protection Agency
FR	Federal Register
HAD	Health Assessment Documents
HEA	Health Effects Assessment
HEAST	Health Effects Assessment Summary Tables
HEED	Health and Environmental Effects Document
HEEP	Health Environmental Effects Profile
HQ	Hazard quotient
HSDB	Hazardous Substance Databank
IRIS	Integrated Risk Information System
ISCST3	Industrial Source Complex, Short-Term Model, Version 3
ISMCS	International Station Meteorological Climate Summary
IWAIR	Industrial Waste Air Model
LOAEL	Lowest-observed-adverse-effect level
MLVSS	Mixed-liquor volatile suspended solids
MRL	Minimum risk level
NCEA	National Center for Environmental Assessment
NESHAP	National Emission Standards for Hazardous Air Pollutants
NOAEL	No-observed-adverse-effects level
OAQPS	Office of Air Quality Planning and Standards
ORD	Office of Research and Development
OSW	Office of Solid Waste
OW	Office of Water
RCRA	Resource Conservation and Recovery Act
REL	Reference exposure level
RfC	Reference concentration
RfD	Reference dose
SCDM	Superfund Chemical Data Matrix
SAB	Science Advisory Board
SIS	Surface Impoundment Study
SSL	Soil Screening Levels
TRI	Toxics Release Inventory
TSDF	Treatment Storage and Disposal Facility
TSS	Total suspended solids

Acronyms and Abbreviations (continued)

URF	Unit risk factor
WHO	World Health Organization
WMU	Waste management unit

1.0 Introduction

This document provides technical background information on the Industrial Waste Air (IWAIR) model. This document is a companion document to the *IWAIR User's Guide*, which provides detailed information on how to install and use the model.

1.1 Guide for Industrial Waste Management and IWAIR

The U.S. Environmental Protection Agency (EPA) and representatives from 12 state environmental agencies developed a voluntary *Guide for Industrial Waste Management* (hereafter, the *Guide*) to recommend a baseline of protective design and operating practices to manage nonhazardous industrial waste throughout the country. The guidance is designed for facility managers, regulatory agency staff, and the public, and it reflects four underlying objectives:

- Adopt a multimedia approach to protect human health and the environment.
- Tailor management practices to risk in the enormously diverse universe of waste, using the innovative, user-friendly modeling tools provided in the *Guide*.
- Reaffirm state and tribal leadership in ensuring protective industrial waste management, and use the *Guide* to complement state and tribal programs.
- Foster partnerships among facility managers, the public, and regulatory agencies.

The *Guide* recommends best management practices and key factors to consider to protect groundwater, surface water, and ambient air quality in siting, operating, and designing waste management units (WMUs); monitoring WMUs' impact on the environment; determining necessary corrective action; closing WMUs; and providing postclosure care. In particular, the guidance recommends risk-based approaches to choosing liner systems and waste application rates for groundwater protection and to evaluating the need for air controls. The CD-ROM version of the *Guide* includes user-friendly air and groundwater models to conduct these risk evaluations.

Chapter 5 of the *Guide*, entitled "Protecting Air Quality," highlights several key recommendations:

- Adopt controls to minimize particulate emissions.

- Determine whether WMUs at a facility are addressed by Clean Air Act (CAA) requirements and comply with those requirements.
- If WMUs are not specifically addressed by CAA requirements, use IWAIR to assess risks associated with volatile air emissions from units.
- Implement pollution prevention programs, treatment measures, or emissions controls to reduce volatile air emission risks.

EPA developed IWAIR and this technical background document to accompany the *Guide* to assist facility managers and regulatory agency staff in evaluating inhalation risks. Workers and residents in the vicinity of a unit may be exposed to volatile chemicals from the unit in the air they breathe. Exposure to some of these chemicals at sufficient concentrations may cause a variety of cancer and noncancer health effects (such as developmental effects in a fetus or neurological effects in an adult). With a limited amount of site-specific information, IWAIR can estimate whether specific wastes or waste management practices may pose an unacceptable risk to human health.

1.2 Model Design

IWAIR is an interactive computer program with three main components: (1) an emission model to estimate release of constituents from WMUs; (2) a dispersion model to estimate fate and transport of constituents through the atmosphere and determine ambient air concentrations at specified receptor locations; and (3) a risk model to calculate either the risk to exposed individuals or waste constituent concentrations that can be protectively managed in the unit. The program requires only a limited amount of site-specific information, including facility location, WMU characteristics, waste characteristics, and receptor information. A brief description of each component follows.

1.2.1 Emission Model

The emission model uses waste characterization, WMU, and facility information to estimate emissions for 95 constituents (identified in Table 1-1) for four types of units: land application units, landfills, waste piles, and surface impoundments. Users can add chemical properties to model additional chemicals. The emission model selected for incorporation into IWAIR is EPA's CHEMDAT8 model. This model has undergone extensive review by both EPA and industry representatives and is publicly available from EPA's Web page (<http://www.epa.gov/ttn/chief/software.html>).

To facilitate emission modeling with CHEMDAT8, IWAIR prompts the user to provide the required waste- and unit-specific data. Once these data are entered, the model calculates and displays chemical-specific emission rates. If users decide not to develop or use the CHEMDAT8 rates, they can enter their own site-specific emission rates.

Table 1-1. Constituents Included in IWAIR

CAS Number	Compound Name	CAS Number	Compound Name
75070	Acetaldehyde	77474	Hexachlorocyclopentadiene
67641	Acetone	67721	Hexachloroethane
75058	Acetonitrile	78591	Isophorone
107028	Acrolein	7439976	Mercury*
79061	Acrylamide	67561	Methanol
79107	Acrylic acid	110496	Methoxyethanol acetate, 2-
107131	Acrylonitrile	109864	Methoxyethanol, 2-
107051	Allyl chloride	74839	Methyl bromide
62533	Aniline	74873	Methyl chloride
71432	Benzene	78933	Methyl ethyl ketone
92875	Benzidine	108101	Methyl isobutyl ketone
50328	Benzo(a)pyrene	80626	Methyl methacrylate
75274	Bromodichloromethane	1634044	Methyl tert-butyl ether
106990	Butadiene, 1,3-	56495	Methylcholanthrene, 3-
75150	Carbon disulfide	75092	Methylene chloride
56235	Carbon tetrachloride	68122	N,N-Dimethyl formamide
108907	Chlorobenzene	91203	Naphthalene
124481	Chlorodibromomethane	110543	n-Hexane
67663	Chloroform	98953	Nitrobenzene
95578	Chlorophenol, 2-	79469	Nitropropane, 2-
126998	Chloroprene	55185	N-Nitrosodiethylamine
1319773	Cresols (total)	924163	N-Nitrosodi-n-butylamine
98828	Cumene	930552	N-Nitrosopyrrolidine
108930	Cyclohexanol	95501	o-Dichlorobenzene
96128	Dibromo-3-chloropropane, 1,2-	95534	o-Toluidine
75718	Dichlorodifluoromethane	106467	p-Dichlorobenzene
107062	Dichloroethane, 1,2-	108952	Phenol
75354	Dichloroethylene, 1,1-	85449	Phthalic anhydride
78875	Dichloropropane, 1,2 -	75569	Propylene oxide
10061015	Dichloropropylene, cis-1,3-	110861	Pyridine
10061026	Dichloropropylene, trans-1,3-	100425	Styrene
57976	Dimethylbenz[a]anthracene, 7,12-	1746016	TCDD, 2,3,7,8 -
95658	Dimethylphenol, 3,4-	630206	Tetrachloroethane, 1,1,1,2-
121142	Dinitrotoluene, 2,4-	79345	Tetrachloroethane, 1,1,2,2-
123911	Dioxane, 1,4-	127184	Tetrachloroethylene
122667	Diphenylhydrazine, 1,2-	108883	Toluene
106898	Epichlorohydrin	75252	Tribromomethane
106887	Epoxybutane, 1,2-	76131	Trichloro-1,2,2-trifluoroethane, 1,1,2-
111159	Ethoxyethanol acetate, 2-	120821	Trichlorobenzene, 1,2,4-
110805	Ethoxyethanol, 2-	71556	Trichloroethane, 1,1,1-
100414	Ethylbenzene	79005	Trichloroethane, 1,1,2-
106934	Ethylene dibromide	79016	Trichloroethylene
107211	Ethylene glycol	75694	Trichlorofluoromethane
75218	Ethylene oxide	121448	Triethylamine
50000	Formaldehyde	108054	Vinyl acetate
98011	Furfural	75014	Vinyl chloride
87683	Hexachloro-1,3-butadiene	1330207	Xylenes
118741	Hexachlorobenzene		

*Chemical properties for both elemental and divalent forms of mercury are included.

1.2.2 Dispersion Model

IWAIR's second modeling component estimates dispersion of volatilized constituents and determines air concentrations at specified receptor locations using default dispersion factors developed with EPA's Industrial Source Complex, Short-Term Model, version 3 (ISCST3). ISCST3 was run to calculate dispersion for a standardized unit emission rate ($1 \mu\text{g}/\text{m}^2\text{-s}$) to obtain a dispersion factor, which is measured in $\mu\text{g}/\text{m}^3$ per $\mu\text{g}/\text{m}^2\text{-s}$. The total air concentration estimates are then developed by IWAIR by multiplying the constituent-specific emission rates derived from CHEMDAT8 (or the rates the user specified) with a site-specific dispersion factor. Running ISCST3 to develop a new dispersion factor for each location/WMU is time consuming and requires extensive meteorological data and technical expertise. Therefore, IWAIR incorporates default dispersion factors developed using ISCST3 for many separate scenarios designed to cover a broad range of unit characteristics, including

- 60 meteorological stations, chosen to represent the different climatic and geographical regions of the contiguous 48 states, Hawaii, Puerto Rico, and parts of Alaska;
- 4 unit types;
- 17 surface areas for landfills, land application units, and surface impoundments, and 11 surface areas and 7 heights for waste piles;
- 6 receptor distances from the unit (25, 50, 75, 150, 500, 1,000 meters);
- 16 directions in relation to the edge of the unit (only the one resulting in the maximum air concentration is used).

The default dispersion factors were derived by modeling each of these scenarios, then choosing as the default the maximum dispersion factor of the 16 directions for each WMU/surface area/height/meteorological station/receptor distance combination.

Based on the size and location of a unit specified by the user, IWAIR selects an appropriate dispersion factor from the default dispersion factors in the model. If the user specifies a unit surface area or height that falls between two of the sizes already modeled, IWAIR uses an interpolation method to estimate a dispersion factor based on the two closest modeled unit sizes.

Alternatively, a user may enter a site-specific dispersion factor developed by conducting independent modeling with ISCST3 or with a different model and proceed to the next step, the risk calculation.

1.2.3 Risk Model

The third component combines the constituent's air concentration with receptor exposure factors and toxicity benchmarks to calculate either the risk from concentrations managed in the

unit or the waste concentration (C_{waste}) in the unit that must not be exceeded to protect human health. In calculating either estimate, the model applies default values for exposure factors, including inhalation rate, body weight, exposure duration, and exposure frequency. These default values are based on data presented in EPA's *Exposure Factors Handbook* (U.S. EPA, 1997a) and represent average exposure conditions. IWAIR contains standard health benchmarks (cancer slope factors [CSFs] for carcinogens and reference concentrations [RfCs] for noncarcinogens) for 94 of the 95 constituents included in IWAIR.¹ These health benchmarks are obtained primarily from the Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 1997b, 2001a). IWAIR uses these data either to estimate risk or hazard quotients (HQs) or to estimate allowable waste concentrations. Users may override the IWAIR health benchmarks with their own values.

IWAIR only addresses risk from direct inhalation of vapor-phase emissions. Appendix A discusses the potential for risks attributable to indirect exposures.

1.3 About This Document

The remainder of this background document is organized as follows:

- Section 2, *Source Emission Estimates Using CHEMDAT8*, describes the CHEMDAT8 model used to calculate emissions.
- Section 3, *Development of Dispersion Factors Using ISCST3*, describes how dispersion factors were developed using ISCST3 and how these are used in the model.
- Section 4, *Exposure Factors*, describes the exposure factors used in the model.
- Section 5, *Inhalation Health Benchmarks*, describes the health benchmarks used in the model.
- Section 6, *Calculation of Risk or Allowable Waste Concentration*, describes the risk calculation and the allowable waste calculation.
- Section 7, *References*, lists all references cited in this document.
- Appendix A, *Considering Risks from Indirect Pathways*, describes the types of pathways by which an individual may be exposed to a constituent, explains which pathways are accounted for in IWAIR, and discusses exposures unaccounted for in IWAIR.

¹ At the time IWAIR was released, no accepted health benchmark was available for 3,4-dimethylphenol from the hierarchy of sources used to populate the IWAIR health benchmark database, nor were data available from these sources to allow the development of a health benchmark with any confidence. In addition, IWAIR contains chemical properties for both elemental and divalent forms of mercury, but contains a health benchmark only for elemental mercury; no accepted benchmark was available for divalent mercury.

- Appendix B, *Physical-Chemical Properties for Chemicals Included in IWAIR*, presents the physical-chemical property values included in IWAIR and the sources of those values.
- Appendix C, *Sensitivity Analysis of the ISCST3 Air Dispersion Model*, describes the sensitivity analysis performed on depletion options, source shape and orientation, and receptor location and spacing.
- Appendix D, *Selection of Meteorological Stations*, discusses the approach used for selecting meteorological stations used in IWAIR and describes the region represented by each station.